

mostly from 10 to 12 inches in the region of the Great Lakes. In the Northeast, however, the snowfall was very heavy, ranging from about 25 to more than 60 inches, most of which remained unmelted at the close of the month. The snowfall was light in most of the western mountainous districts and this, coupled with the deficiency during the preceding months of the winter, renders prospects unfavorable for an adequate supply of water for irrigation during the coming season. This condition exists most acutely in the mountains of California and thence northward to Washington.

RELATIVE HUMIDITY.

In the Rocky Mountains and Great Plains, also over the far Southwest, the relative humidity was very generally above the normal, the excess being well-pronounced in Colorado and thence southward, including Arizona and western Texas. In the central valleys and eastern districts excesses and deficiencies were observed indiscriminately, except in New England, where an excess was the rule. In the far West there was a well-defined deficiency which closely outlined the region of deficient precipitation.

SPECIAL FORECASTS AND WARNINGS—WEATHER AND CROPS.

WEATHER WARNINGS.

By ALFRED J. HENRY, Supervising Forecaster.

[Washington, Mar. 13, 1920.]

Strong winds.—The outstanding feature of the month was the fact that well-developed cyclonic systems with circular or oval isobars did not pass inland from the Pacific or southeastward from the Canadian Northwest. On the other hand, the low-pressure systems of the month west of the Appalachians were in the form of extensive NE.-SW. troughs of low pressure in which several centers of minimum pressure appeared. When these troughs approached Atlantic coast districts some one of the shallow depressions within them would develop into an intense cyclone which would move rapidly northeastward. Four such intense cyclones passed over New England and the Canadian Maritime Provinces during the month, each of which was attended by high winds and heavy snow. In addition to these four major storms, a number of minor disturbances approached the coast and made it necessary to issue warnings. In all, warnings of strong winds were issued on nine different occasions, the initial dates of the storm periods being as follows: 2d, 12th, 14th, 17th, 18th, 19th, 24th, 28th, and 29th. The details of each warning follow:

2d.—The great sleet storm in New England and Middle Atlantic States.—High pressure over the Middle Atlantic States and the Atlantic to an unknown distance to the eastward in connection with relatively low pressure off the east Florida coast made it necessary to issue warnings for strong northeast winds, Jacksonville to Hatteras, and these warnings were subsequently extended to Eastport, Me., changed to northwest, Hatteras to Provincetown, Mass., on the 4th and continued from that direction on the 5th and 6th, respectively. The display which began on the south coast on the 2d was not definitely concluded on the New England coast until 10 a. m. of the 8th.

It seems probable that the heavy fall of sleet in portions of the Middle Atlantic and southern New England States on the 4th, 5th, and 6th may be attributed to the underrunning of warm southerly winds by a cold northeasterly current out of the great northern HIGH which apparently blocked the passage of the southern LOW on those dates.

Space will not permit a recital of the damage to beach property due to the waves of the record-breaking high tides of this storm.

12th.—A shallow depression along the middle Gulf coast and rapidly falling pressure made it necessary to issue warnings for strong northeast winds from Jacksonville to Fort Monroe, Va., on the 12th. The warnings were subsequently extended to Eastport, Me.

14th.—During the afternoon of the 14th a secondary disturbance developed over Virginia, the barometer fall-

ing 0.35 inch in 12 hours. By the morning of the 15th a cyclone of much intensity with two centers appeared, one center being over southern New England, the other one over the Province of Ontario. Fresh, shifting gales attended this storm in its movement over New England.

17th.—The display of the 17th was a failure; the winds did not attain the strength anticipated.

18th.—Special observations at noon of the 18th showed that a disturbance was developing over Florida. Assuming that it would move northeastward along the coast, northeast warnings were displayed, Jacksonville to Fort Monroe, Va. The storm, however, moved to the eastward over the Atlantic and the warnings failed.

19th.—On the morning of the 19th a cyclonic storm was centered southeast of Nantucket, evidently having developed from a shallow depression of the 18th over North Carolina. Northwest warnings were immediately displayed from Delaware Breakwater to Eastport, Me. This storm subsequently increased very much in intensity.

24th.—Special observations on the 24th showed that a shallow depression centered over North Carolina was increasing in intensity and warnings were accordingly issued for strong northwest winds, Delaware Breakwater to Nantucket. These warnings were subsequently extended to Eastport, Me. This storm increased greatly in intensity as it passed over the Canadian Maritime Provinces, the barometer reaching the low level of 28.62 inches on the morning of the 26th.

28th.—Warnings for strong easterly winds along the Atlantic coast, Norfolk to Boston, were issued 9:30 a. m. These warnings, owing to the erratic course pursued by the storm, were only partially verified.

29th.—Warnings for strong northwest winds along the east Gulf coast were issued at 1 p. m. of this date. They were fully verified.

Heavy snow.—Heavy snow warnings were issued for New England on the 5th.

Cold waves.—Severe and widespread cold waves were notably infrequent during the month, there being but two occasions when the temperature fell sharply in the Washington Forecast District, viz., on the 15th and 29th.

Killing frost.—Warnings of killing frost in northern and central Florida were issued on the 15th, 16th, and 17th and again on the 26th, 27th, and 28th. Cold wave warnings were issued for north and central Florida on the 29th and for central Florida on the 15th and 26th. The temperature fell to and slightly below freezing on each of these dates.

WARNINGS FROM OTHER DISTRICTS.

New Orleans Forecast District.—The depressions that passed over the district were of slight intensity and did not require storm warnings; but on the 29th an area of high pressure, which had moved southeastward from the northern Rocky Mountain region, was attended by a "norther" on the west Gulf coast, for which northwest-storm warnings were issued the preceding night for Louisiana and the east coast of Texas and were verified. Verifying velocity was reached also at Corpus Christi.

On the morning of the 13th, with high pressure in the Northwest and a wide trough extending from the upper Mississippi Valley and the Lake region to New Mexico and western Texas, cold-wave warnings were issued for Oklahoma, northwestern Texas, and northwestern Arkansas. A cold wave occurred in Oklahoma and extreme northwestern Arkansas; but the temperature fall was less marked in northwestern Texas, owing to the persistence of a shallow area of relatively low pressure over New Mexico, which was attended by easterly to southerly winds and snow at Amarillo, Tex.

An area of high pressure over the central portion of the country on the 15th was accompanied by unusually low temperatures at 8 p. m. and a cold wave was forecast for northern Louisiana and the northern portion of east Texas. Temperatures below freezing occurred as forecast, but the temperature fall was less than that required for a cold wave, as the effects of the cold area passed and a reaction to warmer weather set in quickly.

A cold-wave warning for Oklahoma and extreme northwestern Arkansas was issued during the afternoon of the 20th, on special observations, when the crest of a large area of high pressure was north of North Dakota and moving southward. A large fall in temperature occurred by the evening of the 21st, but temperatures on the morning of the 22d were higher than expected. The pressure remained low over Utah and only moderate cooling occurred during the night.

On the morning of the 28th a large area of high pressure extended southeastward from British Columbia to the Missouri Valley, with shallow depressions to the east and south. Cold-wave warnings were issued for Oklahoma, extreme northwestern Arkansas, and the northwestern portion of east Texas, and a cold wave occurred, with temperatures on the morning of the 29th in close agreement with the forecast. Cold-wave warnings were issued on the morning of the 29th for southern Louisiana and the southeastern portion of east Texas and conditions occurred generally as forecast except that the temperature remained above freezing on the Texas coast. A reading of 31°, usually low for the season, was recorded on the morning of March 1 at New Orleans.

Minimum temperature forecasts were issued when needed for the various portions of the district and stockmen were advised of all severe conditions. Warnings of frost or freezing temperature for the coast or adjacent sections were issued on the 4th, 14th, 15th, 16th, 25th, 26th, and 27th and were generally verified.

Fire-weather warnings for the forest reserves of Oklahoma and Arkansas were issued on the 20th. Con-

ditions occurred as forecast, except with regard to precipitation, of which there was none of consequence on the 21st.—*R. A. Dyke.*

Chicago Forecast District.—A cold wave without warning occurred on the 2d in eastern North Dakota and northwestern Minnesota. The next cold wave overspread all sections from the Missouri Valley eastward during the 13th–14th and warnings were issued only for Minnesota and portions of Iowa and Wisconsin, the temperature falling lower than expected over the remainder of the area.

Cold-wave and cattle warnings were issued on the 19th–20th for the northern Rocky Mountain region, the Dakotas, and the western and central portions of Nebraska and Kansas. The warnings were fully verified only in North Dakota, as the cold wave lost force rapidly on account of the decrease in the intensity of the low-pressure area over the southern Plains States.

No warnings were issued during the remainder of the month and no cold waves occurred, except over a small area in the northern Rocky Mountain region on the 26th and the 28th.—*Chas. L. Mitchell.*

Denver Forecast District.—The month was one of generally fair weather without marked changes in temperature. No special warnings were issued: None were necessary. The important storm period of the month occurred between the 20th and 23d, when rains and snows were general and were successfully forecast. The rains in Arizona resulted in floods in the rivers of that State, particularly in the Gila River and the Colorado River at and below Yuma.—*E. H. Bowie.*

San Francisco Forecast District.—Due to the prevalence of high pressure areas which moved south from Alaska to the northern portion of this district before crossing the Rocky Mountains a woeful deficiency of precipitation occurred during the height of the usual rainy season.

Nearly all of the rain that fell was caused by two low pressure areas which moved from Alberta southwestward to California and Nevada. This is a most unusual track for Alberta storms to take. These storms did not cause any rain of consequence until they had moved far enough south to draw their supply of moisture from the ocean, and as a result the only rainfall of sufficient amount to do any good occurred in southern California. Snowfall in the mountains was markedly deficient. Temperatures, however, nearly everywhere were moderate and no severe cold spells were experienced.

Frost warnings were issued on 13 days for light to heavy frosts in some one or more portions of California. These warnings were as a rule verified, but the frosts were not heavy enough to cause serious damage to citrus fruit, though some almonds were injured during the latter part of the month.

One live-stock warning was sent to places in eastern Washington, eastern Oregon, and Idaho on the morning of the 19th, and it was fully verified.

Four storm warnings and eight small craft warnings were issued in portions of the district. While they were justified, the gales were not severe and no disasters so far as known occurred.—*E. A. Beals.*